

DRILLED PIERS

(9-21-10)

1.0 GENERAL

A. Description

A drilled pier consists of a reinforced concrete section cast-in-place against in situ material or permanent steel casing. A drilled pier is constructed by drilling a borehole, placing reinforcement in the excavation and filling the hole with concrete. Construct drilled piers with the required resistance and dimensions in accordance with the contract and accepted submittals. For this provision, “pier” refers to a drilled pier.

B. Prequalification and Experience Requirements

Use a Drilled Pier Contractor prequalified by the NCDOT Contractual Services Unit for drilled pier work (work code 3090).

Submit documentation that the Drilled Pier Contractor has successfully completed at least 5 drilled pier projects within the last 3 years with diameters, lengths and subsurface conditions similar to those anticipated for this project. Documentation should include the General Contractor and Owner’s name and current contact information with descriptions of each past project. Also, submit documentation of experience with dry and wet placement of concrete and the use of temporary casing or slurry.

Provide verification of employment with the Drilled Pier Contractor for the Superintendent, Drill Rig Operators and Project Manager assigned to this project. Submit documentation that these personnel each have a minimum of 5 years experience in drilled pier construction with past projects of scope and complexity similar to that anticipated for this project. Documentation should include resumes, references, certifications, project lists, experience descriptions and details, etc. Perform work with the personnel submitted and accepted. If personnel changes are required during construction, suspend drilled pier construction until replacement personnel are submitted and accepted.

C. Construction Sequence Plan

Submit two hard copies and an electronic copy (PDF format on CD or DVD) of a drilled pier construction sequence plan for all the drilled piers 30 calendar days before beginning drilled pier construction. Provide detailed project specific information in this plan including:

1. Experience documentation in accordance with Section 1.0, Item B
2. List and size of equipment including: cranes, kelly bars, drill rigs, vibratory hammers, augers, core barrels, cleanout buckets, airlifts and/or submersible pumps,

tremies and/or concrete pumps, casing (diameters, thicknesses and lengths), desanding equipment (for slurry construction), etc.

3. Order of drilled pier construction
4. Casing installation and temporary casing removal methods including the order of telescoped casing removal
5. Drilled pier excavation and bottom cleaning methods
6. Reinforcement placement methods including how the cage will be supported and centered in the excavation
7. Concrete placement procedures including how the tremie or pump will be controlled and what type of discharge control will be used to prevent concrete contamination when the tremie or pump is initially placed in the excavation
8. Concrete mix design in accordance with Section 1000 of the *Standard Specifications*
9. Slurry details (if applicable) including intended purpose, product information, manufacturer's recommendations for use, slurry equipment information and written approval from the slurry supplier that the mixing water is acceptable
10. Procedures for handling drilling spoils and slurry overflow including environmental controls to prevent the loss of concrete, slurry and spoils
11. Methods of how the slurry level will be maintained above the highest piezometric head (if applicable)
12. Crosshole sonic logging (CSL) submittals (if applicable) in accordance with the Crosshole Sonic Logging Special Provision
13. Other information shown on the plans or requested by the Engineer

Do not begin drilled pier construction until the construction sequence plan is accepted. If alternate drilled pier construction procedures are proposed or necessary, a revised submittal may be required. If the work deviates from the accepted submittal without prior approval, the Engineer may suspend drilled pier construction until a revised drilled pier construction sequence plan is submitted and accepted.

D. Preconstruction Meeting

Before starting drilled pier construction, conduct a preconstruction meeting to discuss the installation, monitoring and testing of the drilled piers. Schedule this meeting after all drilled pier submittals have been accepted and the Drilled Pier Contractor has mobilized to the site. The Resident or Bridge Maintenance Engineer, Bridge Construction Engineer, Geotechnical Operations Engineer, Contractor and Drilled Pier

Contractor Superintendent, Drill Rig Operators and Project Manager will attend this preconstruction meeting.

E. Definition of Rock

For the purposes of this provision, “rock” is defined as a continuous intact natural material in which the penetration rate with a rock auger is less than 2” (50 mm) per 5 minutes of drilling at full crowd force. This definition excludes discontinuous loose natural materials such as boulders and man-made materials such as concrete, steel, timber, etc.

F. Rock Socket

When required by a note on plans, provide a minimum penetration into rock as directed by the Engineer.

2.0 EXCAVATION

Perform the excavations required for the drilled piers to the dimensions and elevations shown on the plans or otherwise required by the Engineer, including any miscellaneous grading or excavation to install the pier.

Excavate with a drill rig of adequate capacity. Use a rig that is capable of drilling through soil, rock, boulders, timbers, man-made objects and any other materials encountered. Blasting is not permitted to advance the excavation. Blasting for core removal is only permitted when approved by the Engineer.

Use a drill rig capable of drilling a minimum of 25% deeper than the deepest drilled pier shown on the plans. Use drilling tools equipped with vents designed to stabilize the hydrostatic pressure above and below the tool during extraction from the excavation. For drilled piers constructed with slurry, monitor the rate at which the drilling tools are inserted and extracted so as to minimize sidewall suction action in the excavation. Drilling below the tip elevations shown on the plans may be required to achieve adequate resistance.

A drilling log signed by the Drilled Pier Contractor that includes material descriptions and depths and drilling times and tools used for each material is required for each pier.

Dispose of drilling spoils in accordance with Section 802 of the *Standard Specifications* and as directed by the Engineer. Drilling spoils consist of all excavated material including water removed from the excavation either by pumping or drilling tools. Construct drilled piers at the locations shown on the plans and within the tolerances specified herein. If tolerances are exceeded, the Engineer may require corrective measures to meet the tolerances specified. Construct the drilled piers such that the axis at the top of the piers is no more than 3” (75 mm) in any direction from the position shown in the plans. Construct drilled piers within 2% of plumb for the total length of the piers. Verify plumbness of drilled pier excavations with an approved method such as an inclinometer on the kelly bar. Unless a plan note requires the construction joint to be moved below the ground line,

construct the finished top of pier elevation between 1 inch (25 mm) above and 3" (75 mm) below the top of pier elevation shown on the plans.

When drilling from a barge, use a fixed template that maintains pier position and alignment during all excavation and concrete placement operations. Floating templates (attached to a barge) are not allowed.

Stabilize all drilled pier excavations with steel casing and/or slurry except, as approved by the Engineer, the portions of the excavations in rock as defined by Section 1.0, Item E. Stabilize excavations at all times from the beginning of drilling through concrete placement. When using multiple casings in a telescoped arrangement, overlap subsequent casings a minimum of 24" (600 mm). Provide casing or slurry in rock if unstable material is anticipated or encountered during drilling. When slurry is used, a partially excavated pier is subject to the time requirements in Section 2.0, Item C, Number 1. When slurry is not used, do not leave a drilled pier excavation open overnight unless it is cased to rock.

If a note on plans does not prohibit dewatering and the tip of the drilled pier excavation is in rock as defined by Section 1.0, Item E, dewater the excavation to the satisfaction of the Engineer. The minimum diameter of a drilled pier excavation in rock or an excavation constructed with slurry may be 2" (50 mm) less than the design drilled pier diameter shown on the plans.

In order to remove a casing and substitute a larger diameter or longer casing through unstable or caving material, either backfill the excavation, stabilize the excavation with slurry before removing the casing to be replaced or insert the larger casing around the casing to be replaced before removal.

A. Permanent Steel Casing

Use permanent steel casings as directed by the Engineer and/or as required by a note on plans. Use permanent casings that are clean smooth non-corrugated watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Provide permanent steel casings conforming to ASTM A252, Grade 2 and the following minimum wall thickness requirements.

CASING WALL THICKNESS

Casing Diameter	Minimum Wall Thickness
Less than or equal to 48" (1220 mm)	3/8 inch (9 mm)
Greater than 48" (1220 mm) and less than or equal to 78" (1982 mm)	1/2 inch (12 mm)
Greater than 78" (1982 mm)	5/8 inch (16 mm)

Provide permanent casings with an outside diameter not less than the specified size of the drilled pier. If approved by the Engineer, a permanent casing larger in diameter than the drilled pier design diameter is permitted. However, no payment will be made

for any costs associated with larger permanent casings. Extend the permanent casings from the top of pier elevation or top of permanent casing elevation, if shown on the plans, to a depth no deeper than the permanent casing tip elevation shown on the plans or the revised permanent casing tip elevation approved by the Engineer. Do not extend permanent casings below the permanent casing tip elevation shown on the plans without prior approval from the Engineer. Additional drilled pier length and reinforcement may be required if permanent casings are extended below the permanent casing tip elevation shown on the plans. No payment will be made for the resulting additional drilled pier length, reinforcement and permanent casing unless the Engineer approves the revised permanent casing tip elevation. Install permanent casings in one continuous unit. If splices are necessary for the casing, use an approved method of splicing. Splices are considered incidental and no additional compensation will be made.

Remove any portion of the permanent steel casing that extends above the top of the drilled pier after the Drilled Pier Concrete has achieved a compressive strength of 3000 psi (20.7 MPa).

B. Temporary Steel Casing

Provide temporary steel casing to stabilize drilled pier excavations, protect personnel and prevent caving or sloughing, that is clean smooth non-corrugated watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Use temporary steel casings with a minimum wall thickness of 3/8 inch (9 mm) and an outside diameter not less than the specified size of the drilled pier.

Temporary steel casings that become bound or fouled during construction and cannot be practically removed may constitute a defect in the drilled pier. Improve defective piers to the satisfaction of the Engineer by removing the concrete and extending the pier deeper, providing a replacement drilled pier or other acceptable means. Complete all corrective measures including any additional design work to the satisfaction of the Engineer without additional compensation or an extension of the completion date of the project.

C. Slurry

When slurry use is not noted on the plans, slurry construction is an option. If slurry use is required or an option, polymer slurry use may either be required or prohibited as noted on the plans. If slurry use is required or an option and polymer slurry use is not noted on the plans, polymer slurry use is an option.

If polymer slurry is required or an option, use one of the following polymers listed in the table below:

PRODUCT	MANUFACTURER
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SlurryPro CDP	KB Technologies Ltd. 3648 FM 1960 West, Suite 107 Houston, TX 77068 (800) 525-5237
Super Mud	PDS Company 105 West Sharp Street El Dorado, AR 71730 (800) 243-7455
Shore Pac	CETCO Construction Drilling Products 1500 West Shure Drive, 5 th Floor Arlington Heights, IL 60004 (800) 527-9948
Novagel Polymer	Geo-Tech Drilling Fluids 220 North Zapata Hwy, Suite 11A Laredo, TX 78043 (210) 587-4758

Use polymer slurry and associated additives in accordance with the manufacturer's guidelines and recommendations unless otherwise approved by the Engineer. The Drilled Pier Contractor should be aware that polymer slurry might not be appropriate for a given site. Polymer slurry should not be used for excavations in soft or loose soils as determined by the Engineer. When using polymer slurry, provide a representative employed by the slurry manufacturer to assist and guide the Drilled Pier Contractor on-site during the construction of the first 3 drilled piers unless otherwise approved. If problems are encountered during construction, the Engineer may require the manufacturer representative to return to the site for a time period determined by the Engineer at no additional cost to the Department.

If mineral slurry is required or an option, use mineral slurry composed of bentonite having a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system to minimize bottom sedimentation. Provide bentonite slurry to maintain the stability of the excavation and allow for proper concrete placement. The Drilled Pier Contractor should be aware that salt water with salt concentrations in excess of 500 ppm may adversely affect bentonite slurry.

When slurry is used and permanent steel casing is not required, use temporary casing a minimum of 10 ft (3 m) long at the top of the excavation. Maintain the top of the temporary casing a minimum of 12" (300 mm) above the ground surface surrounding the casing.

Maintain the slurry in the pier excavation at a level not less than 5 ft (1.5 m) or the drilled pier diameter (whichever is greater) above the highest piezometric head along the depth of the pier. It is anticipated that the highest piezometric head is the static water or groundwater elevation (elevation head). However, the Drilled Pier Contractor is responsible for determining the highest piezometric head. The use of steel casing to

maintain the required slurry level is permitted; however, no payment will be made for casing that is used for this purpose. If the slurry level in the excavation suddenly changes or cannot be practically maintained, or the slurry construction method does not produce the desired result, stop the pier construction until an alternate construction procedure is accepted by the Engineer.

Thoroughly premix the slurry with water in tanks before introducing the slurry into the excavation. Submit written approval from the slurry supplier that the mixing water is acceptable. Allow bentonite slurry to hydrate 24 hours in tanks before use. Slurry tanks of adequate capacity are required for slurry circulation, storage and treatment. Excavated slurry pits are not allowed in lieu of slurry tanks without prior approval from the Engineer. Take all steps necessary to prevent the slurry from "setting up" in the excavation. Such methods include, but are not limited to agitation, circulation and/or adjusting the properties of the slurry. Perform desanding operations as necessary to achieve the acceptable sand contents before placing reinforcing steel.

1. Time

Adjust the excavation operations so that the maximum time the slurry is in contact with the sidewalls of the uncased portions of the drilled pier excavation (from time of drilling to concrete placement) does not exceed 36 hours. Do not work on more than two drilled piers per drill rig below the steel casing at any time.

Agitate bentonite slurry in the drilled pier excavations a minimum of every 4 hours. If the bentonite slurry is not agitated a minimum of every 4 hours, the Engineer may require the excavation to be overreamed beneath the steel casing a minimum of 1 inch (25 mm) and a maximum of 3" (75 mm) before performing any other operations in the excavation. Overream with a grooving tool, overreaming bucket or other approved equipment at a minimum spacing of 12" (300 mm).

If concrete placement is not completed within 3 calendar days of beginning drilling, enlarge the design drilled pier diameter by a minimum of 6" (150 mm), or as required by the Engineer, the entire length of the pier at no additional cost to the Department. Enlarging the drilled pier includes replacing the steel casing with steel casing the same size to which the drilled pier is enlarged at no additional cost to the Department.

2. Sampling

Collect all slurry samples using an approved sampling tool. Test slurry samples to determine density, viscosity, pH and sand content to establish an acceptable working pattern during slurry use. Test a minimum of 4 samples during each 8 hours of slurry use for each drilled pier. Take the first sample for the first 8 hours from the slurry tank before introducing slurry into the excavation. Collect the remaining samples from the bottom of the pier excavation. When the test results are acceptable and consistent, a decrease in the testing frequency to one sample per 4 hours of slurry use is permitted.

Before placing reinforcing steel in the drilled pier excavation, extract slurry samples from the bottom of each excavation and at intervals not exceeding 10 ft (3 m) up the excavation, until two consecutive samples produce acceptable values for density, viscosity, pH and sand content.

3. Testing

Have qualified personnel conduct slurry tests to determine density, viscosity, pH and sand content. The following tables show the acceptable range of values for the slurry properties:

BENTONITE SLURRY Sodium Montmorillonite (Commercial Bentonite) Acceptable Range of Values			
Property (units)	At Time of Slurry Introduction	In Excavation Immediately Before Concrete Placement	Test Method
Density, pcf (kg/m ³)	64.3 – 69.1 (1030- 1107)	64.3 – 75.0 (1030- 1201)	Mud Weight (Density) API 13B-1 Section 1
Viscosity, sec./quart (sec./0.95 liters)	28 – 45	28 – 45	Marsh Funnel and Cup API 13B-1 Section 2.2
pH	8 – 11	8 – 11	pH Paper or Glass Electrode pH Meter
Sand Content (percent)	Less than or equal to 4	Less than or equal to 2	Sand API 13B-1 Section 5
Notes: 1. Perform tests when the slurry temperature is above 40°F (4.4°C). 2. Increase density by 2 pcf (32 kg/m ³) in saltwater.			

SLURRYPRO CDP
KB Technologies Ltd.
Acceptable Range of Values

Property (units)	At Time of Slurry Introduction	In Excavation Immediately Before Concrete Placement	Test Method
Density, pcf (kg/m ³)	Less than or equal to 67 (1073)	Less than or equal to 64 (1025)	Mud Weight (Density) API 13B-1 Section 1
Viscosity, sec./quart (sec./0.95 liters)	50 – 120	Less than or equal to 70	Marsh Funnel and Cup API 13B-1 Section 2.2
pH	6 – 11.5	6 – 11.5	pH Paper or Glass Electrode pH Meter
Sand Content (percent)	Less than or equal to 0.5	Less than or equal to 0.5	Sand API 13B-1 Section 5
Notes: 1. Perform tests when the slurry temperature is above 40°F (4.4°C). 2. Increase density by 2 pcf (32 kg/m ³) in saltwater.			

SUPER MUD
PDS Company
Acceptable Range of Values

Property (units)	At Time of Slurry Introduction	In Excavation Immediately Before Concrete Placement	Test Method
Density, pcf (kg/m ³)	Less than or equal to 64 (1025)	Less than or equal to 64 (1025)	Mud Weight (Density) API 13B-1 Section 1
Viscosity, sec./quart (sec./0.95 liters)	32 – 60	Less than or equal to 60	Marsh Funnel and Cup API 13B-1 Section 2.2
pH	8 – 10	8 – 10	pH Paper or Glass Electrode pH Meter
Sand Content (percent)	Less than or equal to 0.5	Less than or equal to 0.5	Sand API 13B-1 Section 5
Notes: 1. Perform tests when the slurry temperature is above 40°F (4.4°C). 2. Increase density by 2 pcf (32 kg/m ³) in saltwater.			

SHORE PAC CETCO Construction Drilling Products Acceptable Range of Values			
Property (units)	At Time of Slurry Introduction	In Excavation Immediately Before Concrete Placement	Test Method
Density, pcf (kg/m ³)	Less than or equal to 64 (1025)	Less than or equal to 64 (1025)	Mud Weight (Density) API 13B-1 Section 1
Viscosity, sec./quart (sec./0.95 liters)	32 – 98	Less than or equal to 75	Marsh Funnel and Cup API 13B-1 Section 2.2
pH	8 – 10	8 – 10	pH Paper or Glass Electrode pH Meter
Sand Content (percent)	Less than or equal to 0.5	Less than or equal to 0.5	Sand API 13B-1 Section 5
Notes: 1. Perform tests when the slurry temperature is above 40°F (4.4°C). 2. Increase density by 2 pcf (32 kg/m ³) in saltwater.			

NOVAGEL POLYMER Geo-Tech Drilling Fluids Acceptable Range of Values			
Property (units)	At Time of Slurry Introduction	In Excavation Immediately Before Concrete Placement	Test Method
Density, pcf (kg/m ³)	Less than or equal to 67 (1073)	Less than or equal to 64 (1025)	Mud Weight (Density) API 13B-1 Section 1
Viscosity, sec./quart (sec./0.95 liters)	45 – 104	Less than or equal to 104	Marsh Funnel and Cup API 13B-1 Section 2.2
pH	6.5 – 11.5	6.5 – 11.5	pH Paper or Glass Electrode pH Meter
Sand Content (percent)	Less than or equal to 0.5	Less than or equal to 0.5	Sand API 13B-1 Section 5
Notes: 1. Perform tests when the slurry temperature is above 40°F (4.4°C). 2. Increase density by 2 pcf (32 kg/m ³) in saltwater.			

When any slurry samples are found to be unacceptable, take whatever action is necessary to bring the slurry within specification requirements. Do not place reinforcing steel until resampling and testing produce acceptable results.

Sign and submit reports of all slurry tests required above to the Engineer upon completion of each drilled pier. The Department reserves the right to perform comparison slurry tests at any time.

4. Slurry Disposal

Comply with all applicable local, state and federal regulations, as well as with the environmental permits of the project when disposing of excavated materials contaminated with slurry. Keep all excavated materials, spoils from the desanding unit and slurry out of the water and contain them at all times.

3.0 CLEANING

Excavate the bottom of the drilled pier to a level plane or stepped with a maximum step height of 12" (300 mm). Clean the bottom of the excavation of loose material using a technique accepted in the construction sequence plan. When the drilled pier excavation is

not hand cleaned, clean the bottom of the excavation with a cleanout bucket and an airlift or submersible pump.

4.0 INSPECTION METHODS AND REQUIREMENTS

After the drilled pier excavation is complete and immediately before placing reinforcing steel and concrete, demonstrate the proper condition of the drilled pier excavation to the Engineer. Provide bosun chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, personnel and all assistance required for the Engineer to inspect the drilled pier excavations.

A. Tip Resistance

If the required tip resistance is not satisfied, increase the drilled pier length as directed by the Engineer. Payment for the additional drilled pier length to achieve adequate resistance will be made per the drilled pier pay items.

One or more of the following tests may be used to verify the conditions and continuity of the material below the tip elevation before placing reinforcing steel.

1. Visual Inspection

The drilled pier excavation may be inspected either by entering the excavation or visually from the top of the excavation.

2. Test Hole

If the tip of the drilled pier excavation is in rock as defined by Section 1.0, Item E, drill a 1-1/2 inch (38 mm) diameter test hole in each drilled pier to a depth at least 6 ft (1.8 m) below the tip elevation.

3. Standard Penetration Test (SPT)

When noted on the plans that an SPT is required, drive a split barrel sampler a minimum of 18" (450 mm) below the drilled pier tip elevation or to refusal in accordance with ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils". Complete the SPT using NW rods through casing or another stabilizing method as approved by the Engineer. Extend the SPT rods from the top of the drilled pier excavation to the drilled pier tip elevation. Firmly support the SPT casing at the top of the drilled pier excavation and rest it on the bottom of the excavation. Conduct the SPT a minimum of 12" (300 mm) away from the sidewalls of the excavation and be sure not to scrape the sidewalls of the excavation while inserting or withdrawing the SPT equipment. Have the SPT device on-site before reaching the drilled pier tip elevation. Report the number of blows for each 6 inch (150 mm) increment driven and a description of the recovered soil sample to the Engineer. The Engineer determines the number of blows required.

B. Bottom Cleanliness

The pier excavation bottom is considered clean if a minimum of 50% of the bottom area has less than 1/2" (13 mm) of sediment and no portion of the bottom area has more than 1-1/2" (38 mm) of sediment as determined by the Engineer.

One or more of the following inspection procedures may be used to inspect the cleanliness of the pier excavation bottom before placing the reinforcing steel and concrete.

1. Visual Inspection

The cleanliness of the drilled pier excavation bottom may be observed either by entering the excavation or from the top of the excavation.

2. Steel Probe

If the excavation is not dewatered or if the Engineer requires it, lower a steel probe to the bottom of the drilled pier excavation to ensure that cleaning has been satisfactorily completed. Supply a steel probe that is 24" (600 mm) long with a flat tip on the sounding end, weighs approximately 9 lbs, #10 rebar (4 kg, #32 rebar), and is suspended from the opposite end with a non-stretch cable.

3. Shaft Inspection Device (SID)

The Engineer may use the SID to take sediment measurements and observe the bottom conditions of the drilled pier excavation at a minimum of five locations selected by the Engineer. The SID is a remotely operated camera capable of observing bottom conditions and measuring sediment underwater and slurry. Each SID inspection (including all 5 locations) takes approximately 1 hour after the equipment has been set up. The Engineer provides the SID and the personnel to operate the device. Notify the Engineer a minimum of 2 calendar days before beginning the drilled pier excavation so the Engineer can arrange for the transportation of the SID to the site and the personnel to perform the inspections. SID inspections are required until the cleanliness of the drilled pier excavation bottom is acceptable in accordance with Section 4.0, Item B of this provision. Do not conduct operations that interfere with the SID inspections. Remove all cleaning and drilling equipment from the drilled pier excavation during any SID inspection. Provide a working area large enough for the SID equipment and within reach of the cabling supplied and clear sight distance of the drilled pier excavation. Assist the Engineer in the transportation and handling of the SID and all the associated equipment and in supporting the electric hoist and/or hoisting tripod for the SID. If required, provide a safe and secure location to park the trailer for the SID while it is unattended on the project site. The Contractor is responsible in terms of both actual expense and time delays for any damage to the SID equipment due to the Contractor's fault or negligence. Replace any damaged equipment at no additional cost to the Department.

5.0 REINFORCING STEEL

Use reinforcing steel in accordance with Section 1070 of the *Standard Specifications*. Completely assemble a cage of reinforcing steel, consisting of longitudinal and spiral bars and place it in the drilled pier excavation as a unit immediately after the proper condition of the excavation is demonstrated to the Engineer. When concrete placement does not follow immediately after cage placement, remove the steel from the pier excavation unless the Engineer directs otherwise. If the cage is removed, recheck pier excavation cleanliness in accordance with this provision before reinstalling the cage.

If the drilled pier excavation is cased down to rock, immediate placement of the reinforcing steel and the concrete is not required. If electing to delay placement of the reinforcing steel and concrete due to the presence of rock, recheck the excavation for proper cleanliness immediately before placing reinforcing steel.

A. Construction, Placement, Support and Alignment

If a longer drilled pier than that shown on the plans is required, adequate reinforcement may be required in the extended length as directed by the Engineer. Lift the cage so racking and cage distortion does not occur. Keep the cage plumb during concrete operations and casing extraction. Check the position of the cage before and after placing the concrete. Position the splice length of the drilled pier cage so that the column or footing has the minimum concrete cover shown on the plans.

Securely cross-tie the vertical and spiral reinforcement at each intersection with double wire. Support or hold down the cage so that the vertical displacement during concrete placement and casing extraction does not exceed 6" (150 mm).

B. Bolsters and Spacers

Set the rebar cage directly on the bottom of the drilled pier excavation with plastic bolsters under each vertical reinforcing bar. Ensure that spacers are tall enough to raise the rebar cage off the bottom of the drilled pier excavation a minimum of 3" (75 mm). If approved by the Engineer, the rebar cage may be hung in the excavation provided the mechanisms supporting the cage are left in place until the Drilled Pier Concrete strength has achieved 3000 psi (20.7 MPa).

In order to ensure the minimum required concrete cover and achieve concentric spacing of the cage within the pier, attach plastic spacer wheels at five points around the cage perimeter. Use spacer wheels that provide a minimum of 4" (100 mm) "blocking" from the outside face of the spiral bars to the outermost surface of the drilled pier except in rock as defined by Section 1.0, Item E and when using slurry construction. Use spacer wheels for slurry construction or in rock that provide a minimum of 2" (50 mm) "blocking". Tie spacer wheels that snap together with wire and allow them to rotate. Use spacer wheels that span at least two adjacent vertical bars. Start placing spacer wheels at the bottom of the cage and continue up along its length at maximum 10 ft (3 m) intervals.

6.0 CONCRETE

Use Drilled Pier Concrete in accordance with Section 1000 of the *Standard Specifications*. Begin concrete placement immediately after inserting reinforcing steel into the drilled pier excavation.

A. Concrete Mix

As an option, use Type IP blended cement with a minimum cement content of 665 lbs/yd³ (395 kg/m³) and a maximum cement content of 833 lbs/yd³ (494 kg/m³). Use No. 78M coarse aggregate in the mix.

Use an approved water-reducer, water-reducing retarder, high-range water-reducer or high-range water-reducing retarder to facilitate placement of the concrete if necessary. Do not use a stabilizing admixture as a retarder in Drilled Pier Concrete without approval of the Engineer. Use admixtures that satisfy AASHTO M194 and add them at the concrete plant when the mixing water is introduced into the concrete. Redosing of admixtures is not permitted.

B. Concrete Placement

Place concrete such that the drilled pier is a monolithic structure. Vibration is only permitted in the top 10 ft (3 m) of the drilled pier. Remove any contaminated concrete from the top of the drilled pier at the time of concrete placement. Contain and remove all wasted concrete that spills over the casing.

Do not twist, move or otherwise disturb temporary casings until the concrete depth in the casing is in excess of 10 ft (3 m) or half the head, whichever is greater, above the bottom of the casing being disturbed. The head is defined as the difference between the highest piezometric head along the depth of the pier and the static water elevation inside the excavation.

Maintain the required concrete depth above the bottom of the innermost casing during casing removal, except when the concrete level is at or above the top of drilled pier elevation. Sustain a sufficient concrete depth above the bottom of casing to overcome outside soil and water pressure. As the casing is withdrawn, exercise care in maintaining an adequate concrete depth within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the Drilled Pier Concrete. Exerting downward pressure, hammering and/or vibrating the temporary casing is permitted to facilitate removal.

Use the water inflow rate to determine the concrete placement procedure after any pumps have been removed from the excavation. If the inflow rate is less than 6" (150 mm) per half hour, the concrete placement is considered dry. If the water inflow rate is greater than 6" (150 mm) per half hour, the concrete placement is considered wet.

Keep a record of the volume of concrete placed in each drilled pier excavation and make it available to the Engineer. For drilled piers constructed with slurry or as

directed by the Engineer, record a graphical plot of the depth versus theoretical concrete volume and actual measured concrete volume for each drilled pier and provide it to the Engineer when finished placing concrete.

1. Dry Placement

Before concrete placement, make certain the drilled pier excavation is dry so the flow of concrete around the reinforcing steel can be verified by visual inspection. If the concrete free fall does not exceed 60 ft (18.3 m), placing the concrete by a central drop method where the concrete is chuted directly down the center of the excavation is permitted.

For drilled piers exceeding 60 ft (18.3 m) in length, use a tremie or a pump to place concrete unless otherwise approved by the Engineer. Support the tremie or pump pipe so that the concrete free fall is less than 60 ft (18.3 m) at all times.

2. Wet Placement

Maintain a static water or slurry level in the excavation before placing concrete underwater. When temporary casing is used as the method to stabilize the excavation, place concrete with a sectional tremie or pump (no continuous tremie).

Once the concrete in the excavation reaches the same elevation as the static water level, placing concrete with the dry method is permitted. Before changing to the dry method of concrete placement, remove the water above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete.

3. Pump and Tremie

Pump concrete in accordance with Article 420-5 of the *Standard Specifications*. Use a steel tremie with watertight joints and a minimum diameter of 10" (250 mm). Use a discharge control to prevent concrete contamination when the tremie tube or pump pipe is initially placed in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 ft (1.5 m) at all times except when the concrete is initially introduced into the pier excavation. If the tremie tube or pump pipe pulls out of the concrete for any reason after the initial concrete is placed, restart concrete placement with a steel capped tremie tube or pump pipe.

4. Placement Time

Place concrete within the time frames specified in Table 1000-2 of the *Standard Specifications* for Class AA Concrete. Do not place concrete so fast as to trap air, slurry, water, fluids, soil or any other deleterious materials in the vicinity of the reinforcing steel and the annular zone between the rebar cage and the excavation walls.

7.0 SCHEDULING AND RESTRICTIONS

If caving or sloughing occurs, compensation will not be provided for additional concrete to fill the resulting voids.

For the first 16 hours after a drilled pier has achieved its initial concrete set (as determined by the Engineer), do not drill adjacent piers, do not install adjacent piles, and do not allow any equipment wheel loads or damaging vibrations within 20 ft (6 m) of the drilled pier.

In the event that the procedures described herein are performed unsatisfactorily, the Engineer may suspend drilled pier construction in accordance with Article 108-7 of the *Standard Specifications*. If the integrity of a drilled pier is in question, the Engineer may reject the pier and require remediation. Remedial measures are proposed by the Contractor and require approval of the Engineer. No compensation will be paid for losses or damage due to remedial work or any investigation of drilled piers found defective or not in accordance with this provision or the plans.

8.0 MEASUREMENT AND PAYMENT

____ *Dia. Drilled Piers* will be measured and paid for in linear feet (meters). The contract unit price bid for ____ *Dia. Drilled Piers* will be full compensation for drilling through any materials encountered. The contract unit price bid for ____ *Dia. Drilled Piers* will also be full compensation for spoils and slurry containment and disposal, any concrete removal, miscellaneous grading and excavation and slurry construction including site assistance and overreaming and enlarging piers. Drilled piers through air or water will be paid for at the contract unit price bid for ____ *Dia. Drilled Piers*. Reinforcing steel will be measured and paid for in accordance with Section 425 of the *Standard Specifications*.

Permanent Steel Casing for ____ Dia. Drilled Pier will be measured and paid for in linear feet (meters). Permanent casings will only be paid for when required by the Engineer or as shown on the plans. Permanent casings will be measured as the difference between the top of casing or pier elevation, whichever is lower, and the permanent casing tip elevation. If a permanent casing can not be installed to the tip elevation shown on the plans, up to 3 ft (1 m) of casing cut-off will be paid for at the contract unit price bid for *Permanent Steel Casing for ____ Dia. Drilled Pier*. The contract unit price bid for *Permanent Steel Casing for ____ Dia. Drilled Pier* will also be full compensation for any permanent casing removal. No payment will be made for temporary steel casings that become stuck, bound or fouled and cannot be practically removed.

SID Inspection will be measured and paid for in units of each. *SID Inspection* will be measured as one per pier. The contract unit price bid for *SID Inspection* will be full compensation for the Engineer to perform SID inspections until the bottom cleanliness is in accordance with this provision.

SPT Testing will be measured and paid for in units of each. *SPT Testing* will be measured as the number SPT tests performed.

Payment will be made under:

Pay Item

_____ Dia. Drilled Piers

Permanent Steel Casing for _____ Dia. Drilled Piers

SID Inspection

SPT Testing

Pay Unit

Linear Foot (Meter)

Linear Foot (Meter)

Each

Each